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A COMPARISON OF AVIAN ASSEMBLAGES FROM INDIVIDUAL PITS AT RANCHO LA BREA, CALIFORNIA

By HILDEGARDE HOWARD

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David K. Caldwell

Editor

A COMPARISON OF AVIAN ASSEMBLAGES FROM INDIVIDUAL PITS AT RANCHO LA BREA, CALIFORNIA

By HILDEGARDE HOWARD[1]

ABSTRACT: Avifaunas of thirteen separate pits at Rancho La Brea are analyzed and compared on the basis of number of individuals per species. At least 133 species are noted, of which 19 are extinct; no one pit contained all species or even all extinct species. Pits differ as to dominant species and relative abundance of different groups of birds. Three pits differ markedly from eight others, and are considered to be of more recent date of accumulation. Two pits assume an intermediate position. Thirteen species are considered critical markers of a typical Pleistocene pit avifauna, constituting 30 per cent or more of the pit assemblages. One pit stands out ecologically because of a large representation of water birds.

INTRODUCTION

The rich avifauna of the Rancho La Brea asphalt deposits has long been appreciated for its outstanding contribution to the knowledge of prehistoric bird life of the Los Angeles Basin. The picture, however, is not static. If, as seems probable, the separate tar accumulations were not wholly contemporaneous in their times of activity and entrapment, an examination of the assemblages of the separate deposits affords a rare opportunity to record numerical changes in the local fauna over a period of a few thousand years, in a manner comparable to studies of existing faunas over a shorter period of time. Over 85,000 avian skeletal parts (or fragments thereof) have been cataloged at the Los Angeles County Museum. Even the richest collection of Recent avian osteology cannot boast so large a representation from a single area.

General censuses of the mammals and birds of the Rancho La Brea deposits were made many years ago (Stock, 1929; Howard, 1930, respectively). These censuses included specimens from all of the Los Angeles County Museum's excavations of 1913-1915 without regard to content of individual deposits.

The first census of a single pit was an analysis of the avian assemblage of Los Angeles County Museum Pit no. 10, in which human bones had been found (Howard and A. Miller, 1939). Pit 10 contained none of the large extinct mammals considered typical for the Rancho La Brea fauna. The avifauna was found to represent "an intermediate stage in the extinction of birds usually considered to be typically Pleistocene," (*op. cit.,* 48) but on the whole to resemble "that of the Recent more closely than that of the Pleistocene."

FAUNAS STUDIED

In the years that have passed since the publication of the report on Pit 10, I have made an individual avian census for each of the bone-bearing deposits

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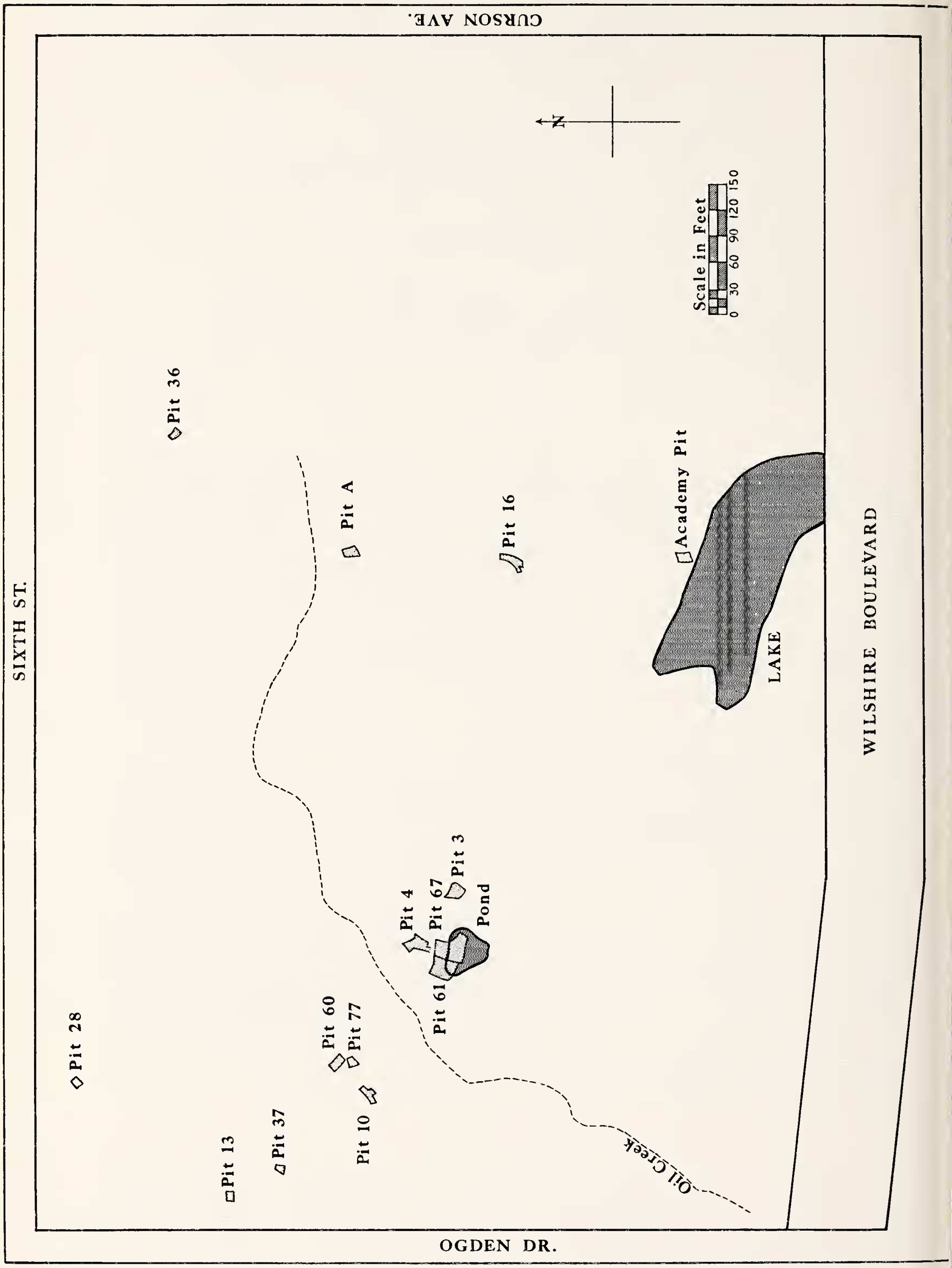

Fig. 1. Map of Rancho La Brea scientific monument showing location of excavations discussed in this paper.

excavated by the Los Angeles County Museum from 1913 to 1915, and one excavated in 1929 (Pit A). The Museum made many test excavations, but comparatively few yielded a good fauna. Some proved to be merely a cap of asphalt or a small tar vent, others had evidently been active traps, but, due to mixture of water with the tar, bones were rotted. The reader is referred, also, to Marcus (1960: 3-4) concerning pit censuses of large mammals, and to Howard (1960: 713) for further details regarding these excavations. For purposes of this report, I have selected only those excavations, or "pits," in which representatives of at least 95 individual birds have been counted. These pits are nos. 3, 4, 10, 13, 16, 28, 36, 37, 60, 61-67, 77, and A. Pit 61-67 was a series of connected pockets of asphalt extending 45-50 ft. east-west and 24 or more feet north-south, and reaching a maximum depth of 20 feet. The other accumulations were rather clearly defined as pits, with maximum dimensions approximately as follows:

Pit No.	Diameter (feet)	Depth (feet)
3	15 x 15	26
4	24 x 18	25
10	12 x 12 (?)	13½
13	9 x 9	21
16	4 x 4 (?)[a]	27
28	7 x 4	8
36	4 (?) x 2 (?)	11
37	"narrow chimney"	8
60	15 x 12	15½
77	12 x 10	20½
A	18 (?) x 15 (?)[b]	20 (?)[b]

A large avian assemblage was also obtained from the excavation made by the Southern California Academy of Sciences prior to 1913, and a census of this is included in the present report; the excavation is hereinafter referred to as "Acad. Pit." The material is now deposited in the Los Angeles County Museum collections. The site was reexamined by the Museum in 1913, as Pit 17, and found to terminate at 20 ft.; lateral dimensions of the part excavated by the Academy were approximately 5 x 7 ft., but the deposit extended somewhat beyond this cut.

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[a] Field notes for Pit 16 state that at a depth of 6-8 ft. the diameter was "hardly more than 4 ft. across and looks as though it may be the bottom of a large deposit the upper portion of which had been eroded away." When the excavation was completed, it was said to be "an almost circular hole with practically vertical walls to 20 ft." Below this it contracted to end at 27 ft.

[b] There are no recorded dimensions for Pit A. The figures given are approximate, based on photographs and the memory of those of us who visited the excavation in 1929.

The thirteen pits analyzed were scattered throughout the 23 acres of Rancho La Brea that form the scientific monument now called Hancock Park. The largest concentration, nine pits, occurred, however, in the northwest quarter. The other four (Pits 36, A, 16 and Acad.) were distributed (in order, respectively) from north to south along the east end of the park (see Fig. 1).

As all skeletal remains were completely disassociated in the deposits, the censuses were made by selecting the most abundant element of each species in each separate pit, and counting either the rights or lefts, whichever were most numerous. For most species, the tarsometatarsus or humerus was the element used.

A complete list of all species identified, and the number of individuals represented in each pit is shown in Table1. There appears to be only a limited correlation between size of pit and number of individual birds in the assemblage. The greatest number of individual birds occurred in Pit 16, which, although the deepest of the pits, was seemingly of small diameter. Possibly, as noted above (footnote, p. 5) a deposit of wider extent had existed and had been eroded away, and the portion excavated was merely a chimney. Pit 77 had good expanse and depth, yet contained fewest birds. Other large pits, such as 3 and 4 had large assemblages. (See Table 1, on pp. 20-24.)

The perching birds (Order Passeriformes) are included in Table 1 so far as they are known as present. The family Fringillidae (sparrow-like birds) is recorded only for Pit A. All fourteen fringillid species are based on upper or lower mandibles and have not been recognized among the other skeletal elements. The beak was seldom preserved in the material excavated by the Los Angeles Museum in 1913-1915, or by the Southern California Academy of Sciences prior to that time. This is, perhaps, due to the method of cleaning the bones. The fringillid species noted in Pit A may have been present in the other pits, but have not, as yet, been recognized among the elements preserved. Identification of the tiny bones of many species of Passeriformes presents a special problem, particularly among the fringillids; there is great osteological similarity not only between species, but between genera as well. Identification of the Los Angeles County Museum's passerine collection (not including Pit A) was begun by Dr. Alden H. Miller of the University of California Museum of Vertebrate Zoology, and the humeri and many of the tarsometatarsi were examined and identified. Dr. Miller, however, does not consider this study completed. The only passerine bones from Pit A studied by Dr. Miller were the mandibles of an extinct icterid related to blackbirds and cowbirds, which Miller (1947) described as *Pandanaris convexa.* The Pit A fringillid identifications, including the description of an extinct species of towhee, *Pipilo angelensis,* were made by Dawson (1948). The other Pit A passerine identifications were made by myself, based largely on upper and lower mandibles except in the case of the larger species of Corvidae. In order that the size of the faunas of the separate pits may be more accurately compared, a total is given for that of Pit A before the addition of the list of fringillid species. Also, because of the lack of complete information concerning the passerine content of all the pits, all members of this order are excluded where proportionate abundance of certain species is a critical factor.

Studies of the Anseriformes are also incomplete, but all elements have been examined and in general the number of species and individuals can be calculated. Woolfenden's (1961) work on the comparative osteology of recent Anseriformes indicates that dependable distinguishing characteristics are not apparent in all skeletal elements of all genera in this order. The tarsometatarsus, for example, which is the most abundant element among the Rancho La Brea anseriforms, he finds undependable in identifying most of the geese. Four species of geese have previously been recorded from Rancho La Brea: *Branta canadensis, Anser albifrons, Anser hyperboreus,* and tentatively, *Anser rossi.* The present study indicates that *Branta nigricans* should be added to this list; the tiny, slender tarsometatarsus seems clearly distinguishable. *Branta canadensis* as listed in Table 1 refers only to the Canada Goose, *Branta canadensis canadensis.* The smaller races can be confused with species of *Anser,* and are included in the figures given for "Geese, sps." Ducks previously recorded are *Anas platyrhynchos, A strepera, A carolinensis, Spatula clypeata*, two diving ducks, and, possibly, another species of teal.

RESULTS

In contrast to the census of 1930, where the total count was 4189 individual birds, the present study shows a minimum of 5845 individuals. This increase is in part due to the addition of material from Pit A and the Acad. Pit to that previously studied, and, in part, to a more detailed study of all skeletal elements and recognition of additional species. However, the method of counting individuals by separate pits (assuming that the bones of one individual did not become scattered in more than one pit) allows for the counting of different elements in different pits, selecting the most abundant for the species in each pit. In the previous census only one element per species could be used for the entire area.

The studies of the avifauna made since 1930 have increased the number of species recognized; the total species count from the thirteen pits is 133, as contrasted with the former 54. Another seven species of birds have been recorded from the University of California excavations at Rancho La Brea, six of which are passerines. The number of extinct species is raised from eleven in the former census to nineteen in the pits here under study. Specimens of three of the newly recorded extinct forms were identified in the former census as representatives of living species: *Gymnogyps californianus,* now recognized as *G. amplus; Mycteria americana,* now *M. wetmorei; Polyborus cheriway,* now (*P.*) *Caracara prelutosus.* Two additional extinct species have been described from the University of California excavations, but have not been found in the pits here studied.

Examining the individual assemblages from the separate pits, we find considerable variability. Of the 133 species, no one pit has more than 93, and the

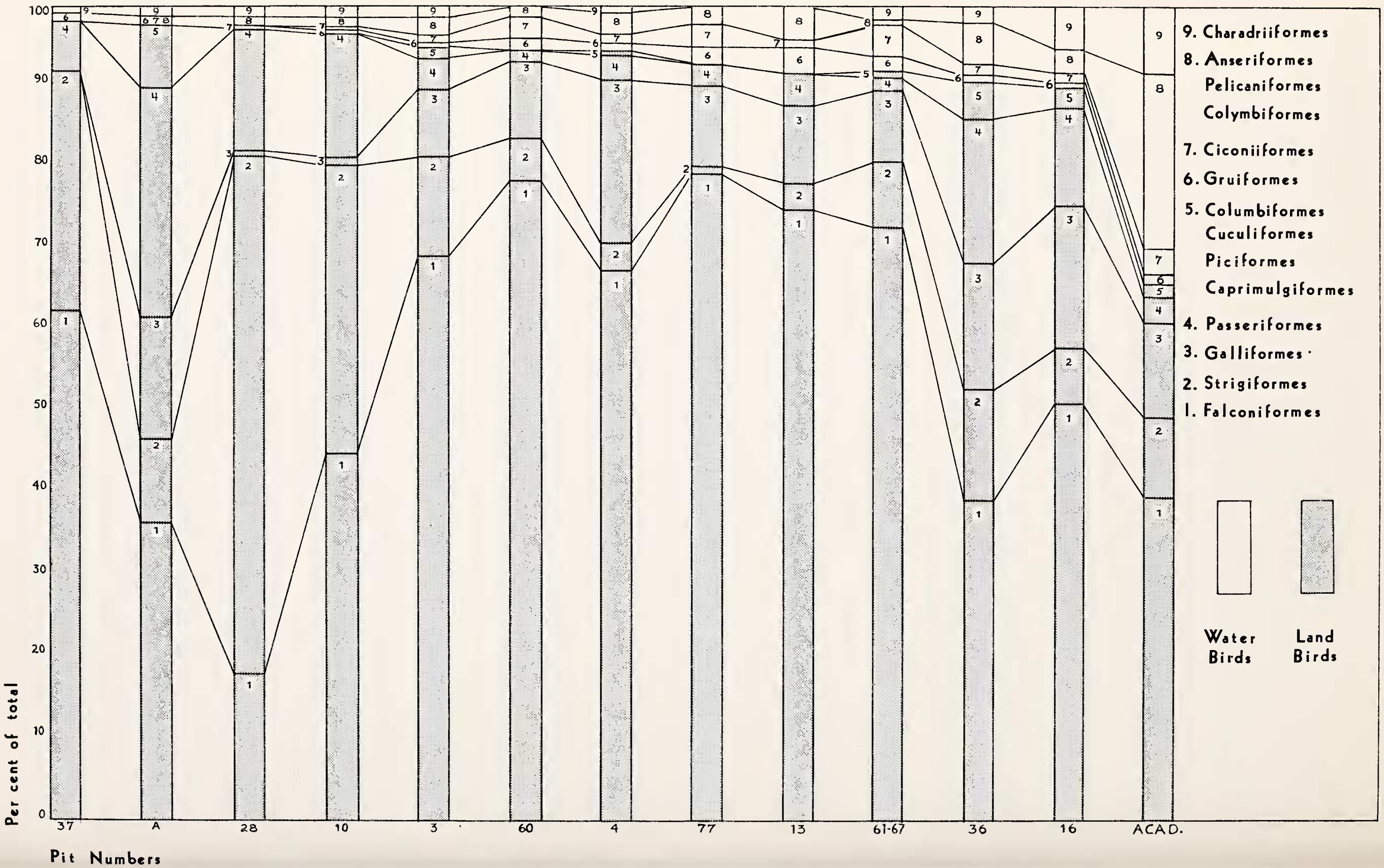

Fig. 2. Relative abundance of avian orders occurring in the thirteen pits. Pits arranged from left to right, in order of increasing abundance of birds associated with water.

minimum number is 17. Only five species are found in all thirteen pits; these are *Cathartes aura, Buteo jamaicensis, Buteo regalis, Corvus corax,* and one extinct species, *Caracara prelutosus.* The number of extinct species in any one pit ranges from 1 to 16.

The raptorial birds, Order Falconiformes and Order Strigiformes, which comprise 67½% of the total avifauna of the combined thirteen pits, also dominate the avifauna of each separate pit. The abnormal preponderance of predators and scavengers in the Rancho La Brea deposits has been frequently commented upon, and is, of course, the result of the nature of the tar accumulations, which acted as traps, baited with carcasses or struggling animals. Actual proportions of predatory birds varied from pit to pit. For example, the Falconiformes constitute 79 per cent of the avifauna of Pit 77, whereas in Pit 36 and Acad. Pit the order constitutes only 38 per cent of the total avifauna, and in Pit A only 36 per cent (even omitting the fringillids from the total count in order to establish better comparability with the other pits). The strigiform content varies from 63 per cent in Pit 28 to only 1 per cent in Pit 77. The two raptorial groups combined constitute from 46 to 91 per cent of the avifauna of the separate pits (see Fig. 2). Only one other order, the Passeriformes, is represented in all thirteen pits. Representation, as presently known, ranges from two species to as many as sixteen (not including the fourteen fringillids in Pit A). Other orders of land birds are represented in from one (Caprimulgiformes) to as many as twelve pits (Galliformes). See Table 1 and Figure 2.

In the combined thirteen pits, waterbirds constitute approximately 7½ per cent of the total non-passerine avifauna. Ducks and geese occur in small numbers in nearly all pits, cranes in ten, storks in ten, herons, ibises and shorebirds occasionally, a coot only in Pit 4, a cormorant only in Pit 10, and two grebes, only in Pit 16. The total number per pit of individual birds of species associated with water ranges from 3 to 42, except in two pits (Acad. and 16) where they number 100 and 155 respectively. In the Acad. Pit they comprise over one-third of the total avifauna. In Pit 16, although the actual number is greater than in the Academy Pit, they represent only 10 per cent of the non-passerine avifauna of the pit.

Aquila chrysaëtos and *Parapavo californicus* are the two most abundant species in the combined count of all pits: *Aquila* first, comprising 16½ per cent of the total assemblage, *Parapavo,* 10 per cent. Pit by pit, however, *Aquila* is most abundant in only four pits (16, 13, 4 and 60, comprising from 23 to 31 per cent of the assemblages, respectively), although it constitutes from 15 to 17 per cent of the assemblages of two others (Pits 3 and 77); it is absent in Pit 37. *Parapavo* comprises 10 per cent or more of total count in five pits (Pits 4, 13, 16, 77 and Acad.) and is the most abundant species in the Academy Pit; it, too, is absent in Pit 37. Other predominating species are evident as individual pits are examined. The ancestral condor, *Gymnogyps amplus,* predominates in Pits 61-67, 3 and 77 (ranging from 14 to 18 per cent of the assemblages, respectively); *Buteo swainsoni* predominates in Pit 37 (24 per cent of the assemblage); *Speotyto cunicularia* in Pits 10 and 28 (13 and 34 per cent of the as-

TABLE 2

Comparison of Pits with regard to possible Age Criteria
(Pits arranged from left to right in order of increasing percentage of individuals of extinct species; note, however, that the same order is not maintained for each category among all the pits)

	Pit 37	Pit 28	Pit 10	Pit 36	Pit A	Pit 16	Pit Acad	Pit 13	Pit 60	Pit 3	Pit 4	Pit 61-67	Pit 77
Abundance of individuals of extinct species relative to total non-passerine assemblage (in per cent)	0.6	4.4	5.7	24.0	26.3	38.9	39.5	41.1	47.8	51.1	53.2	58.0	63.5
Abundance of small raptors relative to total raptorial count (in per cent)	100.0	96.2	89.1	73.6	71.4	41.3	58.7	33.1	34.3	47.9	36.6	47.8	36.7
Ratio of abundance of *Cathartes aura* to *Coragyps occidentalis*	5:0	1:0	3⅓:1	3:1	1:0	1:12	1:8	1:18	1:9	1:19	1:15	1:9	1:14
Ratio of abundance of *Sturnella neglecta* to *Pica nuttalli*	5:0	14:0	76:1	1:15	1:3⅓	1:9	1:3	1:4	0:1*	1:6	1:36	0*	1:0*

*The scant passerine material from Pits 60, 61-67 and 77, makes these ratios subject to question.

semblages, respectively); *Pica nuttalli* in Pit 36 and Pit A (9 and 10 per cent, respectively, omitting fringillids in Pit A). *Haliaeetus leucocephalus* constitutes 17 per cent of the assemblage in Pit 13, but is surpassed by *Aquila chrysaëtos* in the same pit.

When the pits are examined in the light of the information gleaned from the study of Pit 10, they fall into two general groups. Pits 28 and 37 closely resemble Pit 10 in the graphically depicted comparisons with Pits 3 and 4 presented by Howard and Miller (1939: 45), showing lesser numbers of extinct individuals and greater numbers of small vs. large raptors. Further resemblance to Pit 10 is noted in predominance of the living Turkey Vulture, *Cathartes aura,* over the extinct vulture of similar size, *Coragyps occidentalis* (*op., cit.:* 44). Among the passerines resemblance is again observed in the increase in abundance of meadowlarks *(Sturnella neglecta)* and accompanying diminution of magpies *(Pica nuttalli),* seemingly correlated with the giving way of the live-oak, brushland association to the more open grasslands characteristic of the area in Recent time *(op. cit.:* 48). These aspects of Pit 10 formed the basis for the conclusion noted above (p. 3) regarding the recency of Pit 10. As they occur in combination with the absence of typical large Pleistocene mammals in Pits 28 and 37, as well as in Pit 10, there seems little doubt that they may properly be used as age criteria, at least in separating Recent from typical Pleistocene accumulations; to a lesser extent they may be useful in determining the relative ages of the Pleistocene pits. In Table 2, Pits 10, 28 and 37 are contrasted with the other pits with respect to these criteria. The figures of abundance of raptors are altered slightly from those used in the Pit 10 study, to include small vultures and caracara as well as hawks, falcons and owls in the category "small raptors." The relative abundance of extinct and living species and of large and small raptors is also shown graphically in Figures 3 and 4. In both of these categories, and in the ratio of *Cathartes* to *Coragyps,* Pits 37, 28 and 10 assume the same relative positions with respect to each other, Pit 37 seemingly most recent, followed in apparent chronological order by Pit 28 and Pit 10. These three pits are quite clearly set apart from Pits 3, 4, 13, 16, 60, 61-67, 77 and Acad. Pits 36 and A assume a somewhat intermediate position with respect to numbers of extinct individuals and small vs. large raptors. In the relative abundance of Turkey Vultures, resemblance is to the more recent pits, whereas in predominance of *Pica* over *Sturnella* the opposite is the case. In Pit 36, horse, bison, wolf and mastodon are recorded in the field notes and catalog. Marcus (1960:4) found the fauna to be too small to include in his census so there is no count of individuals. The mammalian fauna of Pit A has never been recorded. Cursory examination of the material from that pit indicates that typical Pleistocene species were present, but abundance has not been estimated. Among themselves, the other eight pits do not assume the same relative positions under the four categories except that Pits 4 and 77 (omitting the questionable passerine category) fall consistently among the four "oldest" percentages, and the Acad. Pit is found at the opposite extreme.

The entire group of eight older pits (nos. 3, 4, 13, 16, 60, 61-67, 77 and

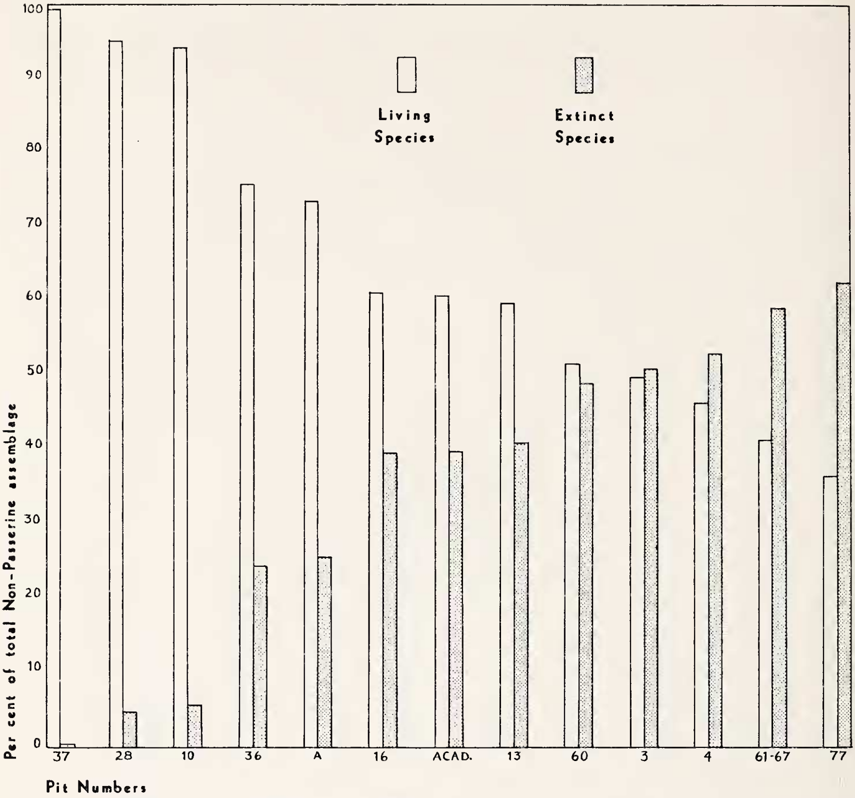

Fig. 3. Abundance of individuals of living and extinct species in each of the thirteen pits, expressed in per cent of the total non-passerine assemblages.

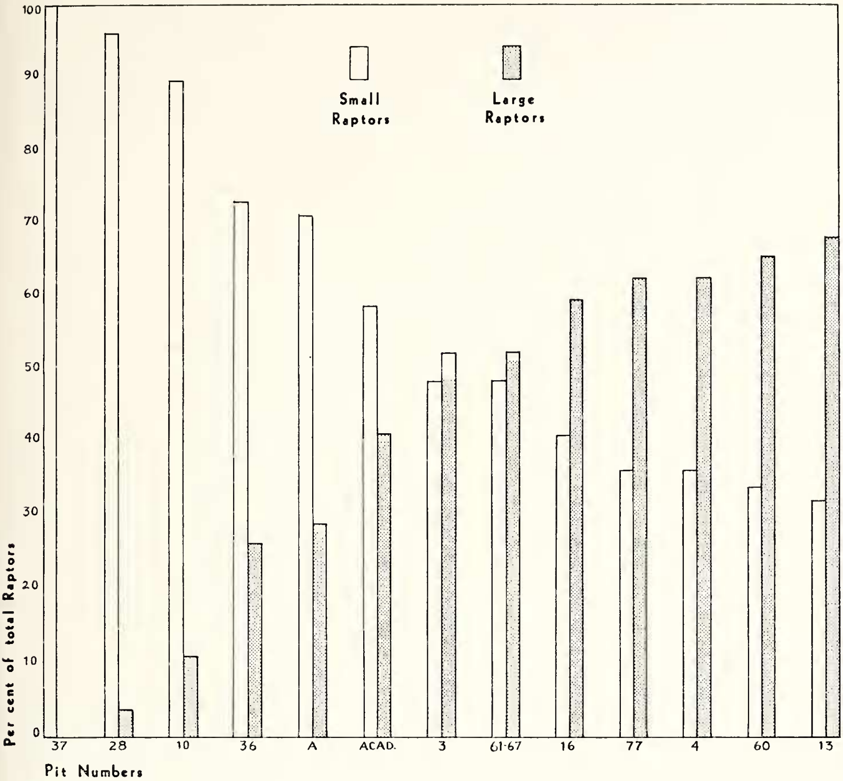

Fig. 4. Abundance of large and small raptors in each of the thirteen pits, expressed in per cent of total count of individuals of the orders Falconiformes and Strigiformes. Large raptors: *Teratornis merriami,* two condors, seven species of eagles; small raptors: two small cathartid vultures, one small aegypiine vulture, caracara, ten species of hawks, four species of falcons, and nine species of owls.

Acad.) contained a combined total of 109 species. Omitting passerines, seventeen are found in all eight pits and constitute from 37 per cent to 92 per cent of the total non-passerine assemblage per pit. They might, therefore, be considered the nucleus of the typical Rancho La Brea Pleistocene avifauna. These are as follows (extinct species starred; four previously noted as common to all pits marked with a dagger):

- Ciconiiformes
  - *_Ciconia maltha_
- Galliformes
  - *_Parapavo californicus_
- Gruiformes
  - _Grus canadensis_
- Strigiformes
  - *_Strix brea_
- Falconiformes
  - †_Cathartes aura_
  - *_Coragyps occidentalis_
  - *_Gymnogyps amplus_
  - *_Teratornis merriami_
  - †_Buteo jamaicensis_
  - †_Buteo regalis_
  - *_Buteogallus fragilis_
  - *_Spizaetus grinnelli_
  - _Aquila chrysaëtos_
  - _Haliaeetus leucocephalus_
  - *_Neogyps errans_
  - *_Neophrontops americanus_
  - †*_Caracara prelutosus_

With the possible exception of _Ciconia maltha_, which is questionably represented in Pit 10, all seventeen species are noted in Pit 10, but in reduced numbers (24 per cent of the total non-passerine assemblage). However, the preponderance of this representation is constituted by individuals of the four non-passerine species common to all pits, and a truer comparison may be made by omitting these four species. The remaining thirteen species comprise only 7.9 per cent of the non-passerine assemblage of Pit 10, 5 per cent of that of Pit 28 (only four species represented), and 1.2 per cent of that of Pit 37 (only one species represented). In Pit A and Pit 36, the relative abundance of individuals of these critical species is 31.7 and 29.8 per cent of the non-passerine assemblage, respectively, with only twelve of the species represented in Pit A and ten in Pit 36. The thirteen species constitute 61½ to 63 per cent of the assemblages of Pits 3, 16, and 61-67, and 81 to 83½ per cent of those of Pits 4, 13, 60 and 77. The Acad. Pit falls between Pit 36 and Pit A, with a percentage of 30.1. In this instance, however, an ecological factor undoubtedly affects the percentage. The Acad. Pit held a higher proportion of water birds than any other pit, and only two species associated with water are included among the birds common to the other seven older pits. When a percentage is taken with water birds omitted, the proportion of "critical" species in the Acad. Pit rises to 10 per cent above the figure for Pit 36. The other pits maintain the same grouping as before, with slightly revised percentages. In order to place the Acad. Pit more accurately with respect to the other pits in graphic

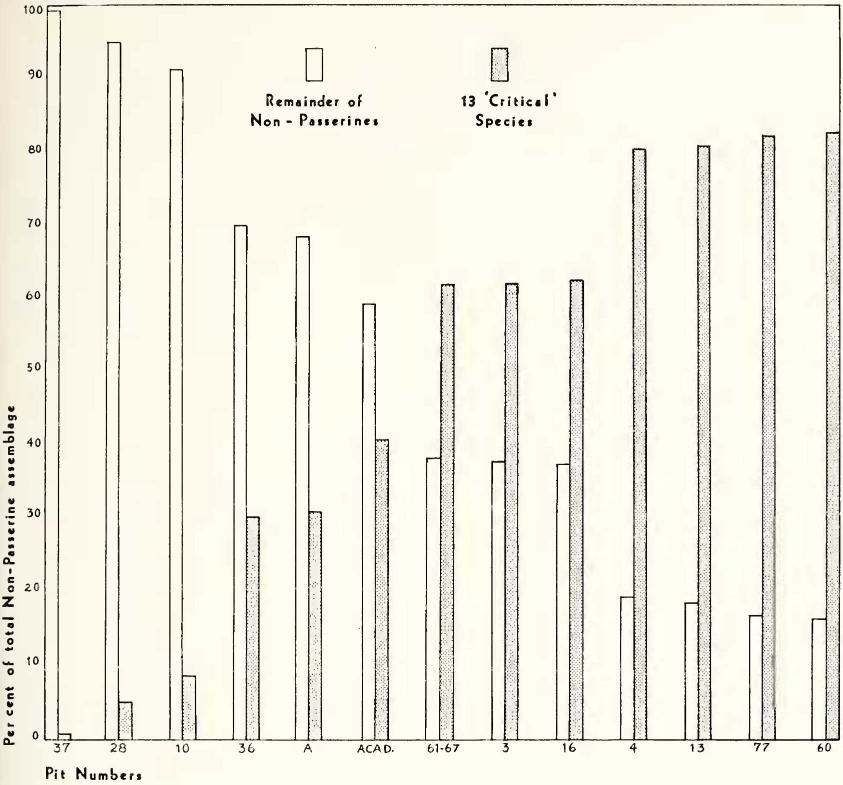

Fig. 5. Abundance (in each pit) of individuals of the thirteen "critical" species, compared with those of the remaining non-passerine species, expressed in per cent of the total non-passerine assemblages. An adjustment of 10 per cent has been made for the Acad. Pit to compensate for the ecologic factor of abundance of waterbirds (see text, p. 16).

form, an upward adjustment of 10 per cent is made in the abundance of "critical" species in that pit in Figure 5.

The extinct species not included in the above list occurred in varying abundance. *Breagyps clarki* was absent only in Pit 60 of the eight older pits, but occurred in none of the three Recent pits, nor Pits 36 and A; *Morphnus woodwardi* was absent in Pits 13 and 77 as well as Pits 28, 37, 36, and A, but is recorded from Pit 10; *Strix brea* was absent in Pits 13, 60, and 77, and in all Recent pits and Pit 36, but was present in Pit A; *Anabernicula minuscula* occurred in the Acad. Pit, Pit 16, Pit 36, and, tentatively (one young tarsometatarsus), in Pit 28; *Ectopistes migratorius* occurred only in Pits 16, 61-67 and 36; *Wetmoregyps daggetti* in the Acad. Pit, Pit A and Pit 4; *Mycteria wetmorei* only in the Acad. Pit; and *Pandanaris convexa* and *Pipilo angelensis* are, so far, known only from Pit A.

DISCUSSION AND CONCLUSIONS

Marcus (1960:10) concluded, after analyzing the large mammal content of Pits 3, 4, 13, 16, 60, 61-67, and 77, that the differences detected in relative abundance of mammal species in these pits had chronological significance, noting that "Either each pit was continuously active for a different interval of time, or the separate pits' periods of quiescence and entrapment were not coincident even though their total times of activity may have been roughly equivalent." He commented also on the Pit 10 study (Howard and Miller, 1939) and the few other studies that have contributed additional evidence in regard to probable age differences among the pits, namely, Brattstrom (1953) concerning reptiles and amphibians of two University of California excavations and four of the Los Angeles County Museum's, of which Pit 3 and Pit A are included in the present study; Nigra and Lance (1947) and Menard (1947) concerning inter-pit differences in average lengths of the metapodials of dire wolf and saber tooth cat, respectively, analyzed for Pits 3, 4, 13, 61-67, and 77. Although each study suggests chronological differences, no specific order of arrangement has been suggested for these five pits or the additional two studied by Marcus (Pits 16 and 60). Brattstrom (*op. cit.:* 379), however, suggests that Pit 3 is older than Pit A.

The faunal changes that may have occurred between the periods of accumulation of the various pits were apparently quite gradual. The carbon-14 date of approximately 14,500 years Before Present (see Howard, 1960: 713) for Pit 3 indicates a relatively short span of years in which the transition between the typical Pleistocene fauna as observed in Pit 3, and that of today took place. Unfortunately there are no dates available for Pits 10, 28, or 37. However, a human artifact of a type previously unknown to occur in California, which was found in a pocket within Pit 61-67, has been dated at approximately 4450 years B P (Howard, *op. cit.:* 714). Faunal association with the artifact cannot be determined owing to considerable cave-in noted in this area. The record, however, at least provides a known date of occurrence of man in the Rancho La Brea area, although not necessarily the earliest. Only one other specimen from Rancho La Brea has been given a radiocarbon test (Douglas, 1952: 20). Unfortunately this was a sample of wood for which the pit is not known; the method of dating, too, was experimental, so results are neither completely satisfactory, nor useful in the present study. The date obtained was 16,325 + or − 2000 years B P. Pieces of wood are available from Pit 16 and Pit 4 and it is hoped that these specimens will be tested in the near future. The two dependable carbon-14 dates now available suggest that the faunal changes noted between Pit 3 and Pit 10 (which contained human bones) took place within 10,000 years or less. The lesser differences noted between assemblages of the older pits would, therefore, seem to have required a shorter time span between the periods of activity of these pits.

As noted above, Marcus referred to the possibility of intermittent periods of activity of the separate pits. The present writer (Howard, 1960: 713) recorded the occurrence of a layer of oxidized asphaltum and clay at the 15 ft. level in Pit 3 that "suggests a period of quiescence between the entrapment of the animals represented in the lower beds and those in the upper"; the dating came from above this layer, the tested tree being rooted at a depth of 12 ft. A peculiarity of activity in the area of Pits 3, 4 and 61-67 is worthy of note, also, as pertinent to the matter of possible intermittent periods of trapping. These three pits occurred rather close together, within a radius of 50 ft. In landscaping the park in 1951, plans called for filling these pits, which had been left open after excavation. Underground activity was such, however, that this proved impossible. With two pits filled, filling the third resulted in an outbreak of tar in one of the others. Nor could this outbreak be filled without further bubbling up in another. Today one pit appears in this area, not precisely located within the boundaries of any one of the previous three. The activity encountered here is suggestive of what could have occurred in the past over a longer period; as one pit hardened over, activity may have started up in another spot close by. The number of pockets found in Pit 61-67 add credence to such a supposition. It seems quite probable that Pits 3, 4, and 61-67 were not all active at the same time, but their periods of activity may very well have overlapped.

Establishing an absolute chronological pattern among all the pits may prove an impossible task, although evidence points to at least a few distinctive sites. Obviously, final conclusions regarding chronology of pit activity, and both spatial and chronological ecology of the Rancho La Brea area cannot be reached until all the components of each separate pit are analyzed. Among the birds, further study of the Passeriformes is particularly essential. The present study has, however, added some significant facets to the general picture.

Certain enumerated characteristics of the avifaunas of Pits 10, 28 and 37 set these three pits apart from the others as having been active within Recent time. These characteristics can, to a limited extent, be considered criteria of Recent age, and when applied to the other ten pits, suggest that Pits 36 and A, though more Pleistocene than Recent in general aspects, were probably active nearer the end of the Pleistocene than were the other eight pits. The Acad. Pit consistently approaches Pits 36 and A in these age criteria, whereas Pits 77 and 4 are among the four "oldest" in each category. The other pits vary in relative position. The occurrence of large numbers of water birds in Pit 16 and the Acad. Pit (pits that are not far apart spatially) does not necessarily imply contemporaneity. The area could have held a pond or marsh over a long period of time during which first one site then the other may have been operative, or the activity could have been intermittent and overlapping. Pit A, which was about the same distance from Pit 16 as was the Acad. Pit, but to the north, is second only to Pit 37 in paucity of water birds. Pit A agrees with both Pit 16 and Pit 36 (still farther to the north) in abundance of quail and magpies, but the predominance of extinct turkeys over quail in Pit 16 again suggests an age difference. Both quail and magpie (as well as turkeys) are greatly diminished in numbers, or absent entirely, in the three Recent pits.

Particular occurrences of extinct species lead one to speculate as to their habits, or their date of extinction. *Anabernicula minuscula,* for example, occurs in greatest abundance in the Acad. Pit, second only to the ducks among the water birds represented. Does this suggest that *Anabernicula,* too, was a swimmer, more ducklike than gooselike in habit? So far there seems to be no clue to the habits of the long-legged Daggett Eagle (*Wetmoregyps daggetti*) in its rare appearance in only three pits, A, Acad., and 4. There are no aspects of these pits to suggest particularly close contemporaneity or ecological similarity. Elsewhere, the species has been recorded from San Josecito Cave, Mexico, and the Carpinteria asphalt deposits in California, where it is best represented. As Carpinteria is generally believed to have been a more wooded area than Rancho La Brea, the localized presence of *Wetmoregyps* at the latter site may have been correlated with the occurrence of a favored type of tree. A possible explanation of the rarity of the Passenger Pigeon (assuming that its flocking habits were the same in the distant past as within historic time) is that the few individuals represented were migratory strays.

The fact that the Caracara is the only one of the extinct species to occur in all of the pits, suggests that this species was one of the last to disappear. Possibly its descendants continued on even longer elsewhere, for the species showed marked similarity to the Caracara of Guadalupe Island, which has become extinct within historic time. It seems highly probable, also, that the living *Gymnogyps californianus* is a direct descendant of *G. amplus.* Apparently *Coragyps occidentalis* was already giving way to *Cathartes aura,* at least in this area, before the end of the Pleistocene, if the ratio of *Cathartes* to *Coragyps* in Pits 36 and A are any indication of conditions.

The full story of extinction, of course, cannot be told from a single area. Even species still living disappeared from the later pits at Rancho La Brea as they moved into other localities. The present survey, however, provides significant documentation of details regarding changes in avian populations under conditions unaffected by civilization (though possibly influenced by aboriginal man), and over a considerable period of time as reckoned in human life span.

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TABLE 1

Number of Individuals per Species in Thirteen Rancho La Brea Pits

(Pits are arranged from left to right in order of abundance of individuals in the assemblage)

	Pit 16	Pit 4	Pit 10	Pit 3	Pit A	Pit 61-67	Pit Acad	Pit 13	Pit 37	Pit 36	Pit 28	Pit 60	Pit 77	TOTALS 13 Pits
COLYMBIFORMES (Grebes)														
Podiceps, sp.	1													1
Podilymbus podiceps	1													1
PELECANIFORMES (Cormorants, etc.)														
Phalacrocorax, sp.			2											2
CICONIIFORMES (Herons, Storks, Ibises)														
Ardea herodias	1		1	3		3	2					1		11
Butorides virescens						1								1
Florida caerulea						1	3							4
Casmerodius albus						1					1			2
Nycticorax nycticorax						1								1
Botaurus lentiginosus	1		2	2		2	1			1?				9
*Mycteria wetmorei							1							1
*Ciconia maltha	10	8	1?	2	1	4	3	2		1		3	2	37
Plegadis chihi						1	1?							2
Ajaia ajaja?													1	1
ANSERIFORMES (Ducks, Geese, Swans)														
Olor columbianus							1							1
Branta canadensis	3	7		1			3							14
Branta nigricans	2	1?						3						6
Geese (four? sps.)	15 4 sp.	13 4 sp.	4 3 sp.	8 2 sp.	1	1	11 3 sp.	6 3 sp.		4 2 sp.		1	2	66
*Anabernicula minuscula	3						19			1	1?			24
Ducks (six? sps.)	32 6 sp.	4 2 sp.	2 2 sp.	4 2 sp.		1	31 6 sp.	2 2 sp.		4 3 sp.	1			81

FALCONIFORMES (Birds of Prey)														
Cathartes aura	2	4	10	2	1	2	1	1	5	3	1	1	1	34
*Coragyps occidentalis	25	61	3	38		18	8	18		1		9	14	195
*Gymnogyps amplus	4	33	1	88	2	42	6	11		3		7	18	215
*Breagyps clarki	1	3		7		6	1	1					2	21
*Teratornis merriami	13	20	6	22	1	22	3	5		1	1?	7	4	105
Elanus leucurus			1	1						1				3
Accipiter gentilis	2													2
Accipiter striatus	2	1	1	1										5
Accipiter cooperi	17	16	1	2	9	2	3					2		52
Buteo jamaicensis	17	8	49	6	6	6	2	1	4	3	2	1	3	108
Buteo swainsoni	1	1	38	19	1	13	2		42	8	4		1	130
Buteo lagopus			4		1?		1				1			7
Buteo regalis	2	4	47	10	2	16	4	1	32	3	2	2	2	127
Buteo, sp.?	4	2			2			1				1	1	11
*Wetmoregyps daggetti		4			3		2							9
*Buteogallus fragilis	27	17	2	9	4	6	3	4		5		4	2	83
*Morphnus woodwardi	3	5	2	6		6	1					2		25
Aquila chrysaëtos	382	238	48	85	22	28	20	58		14	4	44	17	960
*Spizaetus grinnelli	35	30	4	8	4	7	7	3				4	3	105
Haliaeetus leucocephalus	66	28	3	11	2	4	11	41				6	3	175
*Neogyps errans	32	20	2	3	3	3	3	2				5	1	74
*Neophrontops americanus	36	40	4	18	2	12	10	10		2		5	3	142
Circus cyaneus	4	8	84	18	3	4	3		21	12	6	1		164
*Caracara prelutosus	144	40	3	28	14	13	12	15	1	6	3	8	2	289
Falco mexicanus	3	2	10	1	1	1	2	2			1	1		24
Falco peregrinus	3		15	1	2	3	2	1	1		1			29
Falco columbarius	3	1	2	2	5			1			1	1		16
Falco sparverius	24	8	8	3	23		3	4	2	2	1		1	79
GALLIFORMES (Fowl)														
Lophortyx californicus	84	7	1		27	1	5			13				138
*Parapavo californicus	238	173	10	42	21	26	30	24		11	1?	13	10	599
GRUIFORMES (Cranes, rails, etc.)														
Grus americana	1							1						2

	Pit 16	Pit 4	Pit 10	Pit 3	Pit A	Pit 61-67	Pit Acad	Pit 13	Pit 37	Pit 36	Pit 28	Pit 60	Pit 77	TOTALS 13 Pits
Grus canadensis	6	6	5	2	1	4	4	6	2	1		2	2	41
Fulica americana		1												1
CHARADRIIFORMES (Shorebirds)														
Charadrius vociferus	14		1				2			1				18
Squatarola squatarola		1	1				1							3
Capella gallinago	6			1		1								8
Numenius americanus	1		2			3	1		1					8
Numenius phaeopus		1?	1	2			1				1?			6
Catoptrophorus semipalmatus			2											2
Totanus melanoleucus	12						5			2				19
Erolia alpina	1													1
Limnodromus griseus	4													4
Limosa fedoa?	1			1							1?			3
Crocethia alba?	16									3				19
Recurvirostra americana							1							1
Phalaropus fulicarius?	18									2				20
Shorebirds, (3? sps.)	5 3 sp.				3 3 sp.		8 2 sp.							16
Rissa tridactyla?							1							1
Larus (2? sps.)	1		1											2
COLUMBIFORMES (Pigeons and Doves)														
Columba fasciata	1	1			1									3
*Ectopistes migratorius	1					1				1				3
Zenaidura macroura	17		1	5	2		3			2				30
CUCULIFORMES (Roadrunners, etc.)														
Geococcyx californianus	9	4		1	8		2			1				25
STRIGIFORMES (Owls)														
Tyto alba	2	3	100	28	3	16	8		14	9	22			205
Otus asio	5			1	4		1		1	2	2			16
Bubo virginianus	59	21	7	6	8	3	6	6		2	1	8	1	128
Glaucidium gnoma	1?			1?	2?					1				5
Speotyto cunicularia	15	3	104	9	6		3		31	1	56			228

*Strix brea	5	2		2	4	2	1			1				17
Asio, 2 sps.?	18	5	63	23	3	3	9	1	4	6	21	1		157
Aegolius acadicus	1													1
CAPRIMULGIFORMES (Poorwills, etc.)														
Phalaenoptilus nuttalli					7									7
PICIFORMES (Woodpeckers)														
Colaptes cafer	10	1			5					2				18
Dryocopus pileatus	1													1
Asyndesmus lewisi	5			1						1				7
Sphyrapicus, sp.	1													1
Dryobates, sp.	1													1
Woodpecker, 2 or 3 sps.					4									4
PASSERIFORMES (Perching Birds)														
Tyrannus, sp.	1				3									4
Eremophila alpestris									1					1
Cyanocitta stelleri	1			1	2									4
Aphelocoma coerulescens	3				6?					1				8
Pica nuttalli	91	11	1	12	33?		6	4		15		1		174
Corvus corax	30	12	33	11	3	3	2	3	6	3	5	1	2	114
Corvus cryptoleucus										1				1
Corvus brachyrhynchos	2		12	1	2	1	1				3			22
Corvus caurinus	23	4	1	1	6?			1		3	1			40
Nucifraga columbiana					2									2
Toxostoma redivivum	2				3					1				6
Oreoscoptes montanus	1													1
Turdus migratorius	14				2					2				18
Sialia, sp.					5					2				7
Lanius ludovicianus	1				2									3
Sturnella neglecta	10	3	76	2	10		2	1	5	1	14		1	125
Blackbird, 2 sps.	13 2 sp.	1	1		3					2	2			22
Molothrus ater	1													1
Icterus, sps.					6									6
*Pandanaris convexa					1									1

	Pit 16	Pit 4	Pit 10	Pit 3	Pit A	Pit 61-67	Pit Acad	Pit 13	Pit 37	Pit 36	Pit 28	Pit 60	Pit 77	TOTALS 13 Pits
PASSERIFORMES (Continued)														
Family Fringillidae (Sparrows, etc.)														
Pheuticus melanocephalus					1									1
Hesperiphona vespertina					1									1
Spinus tristis					3									3
*Pipilo angelensis					11									11
Pipilo maculatus					4									4
Pipilo fuscus					2									2
Pooecetes gramineus					1									1
Chondestes grammacus					3									3
Amphispiza bilineata					4									4
Spizella, sp.					6									6
Zonotrichia leucophrys					6									6
Passerella iliaca					2									2
Melospiza melodia					10									10
Fringillidae, sp.					6									6
TOTAL FRINGILLIDS					60									60
TOTAL INDIVIDUALS	1674	887	783	562	373[a]	294	289	240	173	168	161	142	99	5845
TOTAL SPECIES	93	52	53	54	74[b]	42	66	35	17	52	29	28	25	133

*Extinct species.

[a] Total individuals omitting Fringillids, 313.

[b] Total species omitting Fringillids, 60.